Gravelless Drainfields

Recommended Standards and Guidance for
Performance, Application, Design and Operation & Maintenance

Washington State Department of
Health

Washington State Department of Health
Office of Community Environmental Health Programs
New Market Industrial Center
7171 Cleanwater Lane, Building 2
PO Box 47826
Olympia, Washington 98504-7826

Tel: 360.236.3063
FAX: 360.236.2251
Webpage: http://www.doh.wa.gov

Preface

The recommended standards contained in this document have been developed for statewide application. Regional differences may, however, result in application of this technology in a manner different than it is presented here. In some localities, greater allowances than those described here may reasonably be granted. In other localities, allowances that are provided for in this document may be restricted. In either setting, the local health officer has full authority in the application of this technology, consistent with Chapter 246-272 WAC and local jurisdictional rules. If any provision of these recommended standards is inconsistent with local jurisdictional rules, regulations, ordinances, policies, procedures, or practices, the local standards take precedence. Application of the recommended standards presented here is at the full discretion of the local health officer.

Local jurisdictional application of these recommended standards may be:

1) **Adopted as part of local rules, regulations or ordinances—**When the recommended standards, either as they are written or modified to more accurately reflect local conditions, are adopted as part of the local rules, their application is governed by local rule authority.

2) **Referred to as technical guidance in the application of the technology—**The recommended standards, either as they are written or modified to more accurately reflect local conditions, may be used locally as technical guidance.

Application of these recommended standards may occur in a manner that combines these two approaches. How these recommended standards are applied at the local jurisdictional level remains at the discretion of the local health officer and the local board of health.

The recommended standards presented here are provided in typical rule language to assist those local jurisdictions where adoption in local rules is the preferred option. Other information and guidance is presented in text boxes with a modified font style to easily distinguish it from the recommended standards.

Acknowledgements—

The Department of Health Wastewater Management Program appreciates the contribution of many persons in the on-going development, review, and up-dating of the Recommended Standards and Guidance documents. The quality of this effort is much improved by the dedication, energy, and input from these persons, including:

- Geoflow, Inc.
- Lombardi and Associates
- Orenco Systems, Inc.
- Puget Sound Water Quality Action Team
- Sun-Mar Corporation
- Washington State On-Site Sewage Association (WOSSA)
- Washington State On-Site Sewage Treatment Technical Review Committee (TRC)
- Waste Water Technologies

Table of Contents

Introduction—

The gravelless drainfields addressed in these standards represent several different types: pipe, chamber, gravel-substitute, and geocomposites. While the specifics of these types differ, their purpose is the same: meet (or exceed) the characteristics and function of gravel in a conventional gravel-filled drainfield.

In a conventional gravel-filled drainfield the gravel is:

- non-deteriorating;
- provides void space (for the passage and temporary storage of septic tank effluent);
- presents an interface with the infiltrative surface—trench bottom and side-wall soil—(for absorption of the wastewater); and,
- maintains the integrity of the excavation, supporting the soil back-fill and cover.

The advantage of a gravelless drainfield becomes clear when and where suitable gravel is either unavailable, expensive, or where site conditions make moving gravel about difficult or time consuming. In addition to these benefits, the use of gravelless drainfields addresses some of the concerns presented with gravel. Among these are:

- The detrimental effect of gravel impacting and compressing the infiltrative surface when dumped into the drainfield trench from the front-end loader of a backhoe, which may lower the infiltrative capacity of the soil.
- If the quality of the gravel washing process is poor, the silt particles remaining on the surface of the gravel may be washed off when the drainfield is placed into use, resulting is a silt layer on the infiltrative surface, reducing its infiltrative capacity.
- The damaging effect that the transportation of gravel across yards can have on lawns, flowerbeds, shrubs, etc. due to the weight of the material and the size of the heavy equipment needed to effectively move it from the stock pile to the drainfield area.

Gravelless Drainfields—In addition to not using gravel, gravelless drainfields differ from the conventional gravel-filled drainfields in the following ways:

Gravelless Pipe—(See Figure 1a & 1b)

Pipe-based gravelless drainfields are currently available in two approaches: single-pipe, and multiple-pipe.

Single-pipe gravelless drainfields—

- Large diameter pipe is used (typically 8"-10" I.D., 10"-12" O.D.).
- The pipe is wrapped in a layer of geotextile material.

- The excavated trench is typically less than 24" wide (15"-18").
- Serial distribution (drop boxes or crossovers) is more commonly used than parallel distribution (distribution boxes).

Multiple-pipe gravelless drainfields are a new product in the gravelless drainfield market, currently undergoing review by DOH and the TRC. Information about this product is included to facilitate ease and timeliness of inclusion in the recommended standards once approved by DOH.

Multiple-pipe gravelless drainfields—
- Medium diameter pipe is used (typically 4”- 4.5” O.D.)
- Pipe, in ten-foot lengths, is bundled in groups of 3 or 5 pipes.
- Bundles of pipe are grouped in various configurations to accommodate different widths and depths of trenches or beds.
- One of the pipes in the bundle is designed and designated for end-to-end connection to facilitate distribution of wastewater throughout the drainfield trench or bed.

Figure 1a. Typical Single-pipe Gravelless Drainfield, Cross-Section

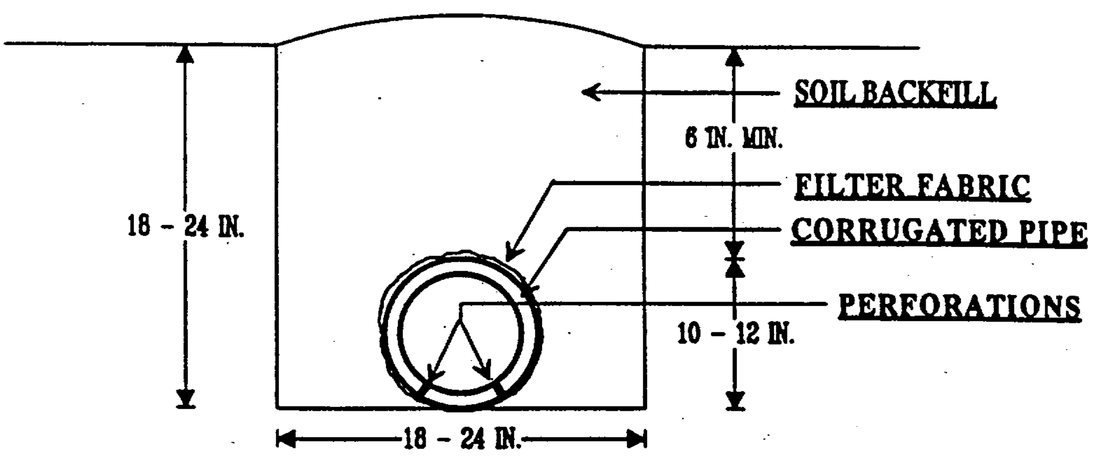


Figure 1b. Typical Multiple-pipe Gravelless Drainfield, Cross-Section

Gravelless Chambers—(See Figure 2)

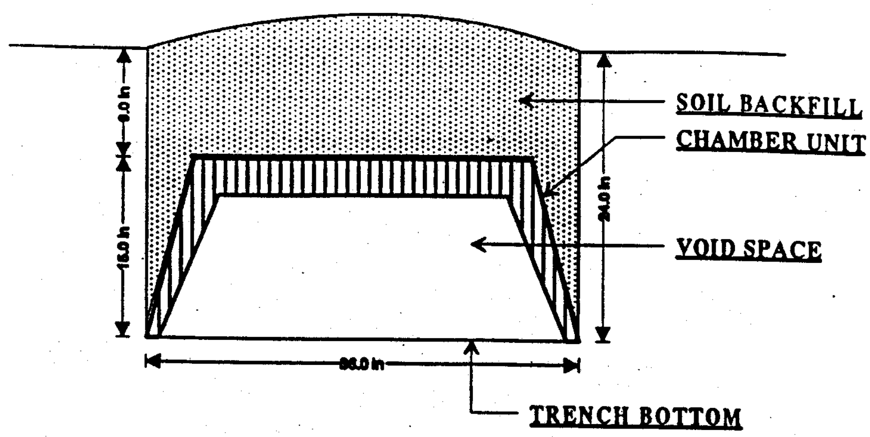
- Molded chambers, of various dimensions, are used. The chambers replace the gravel-supported void space with chamber-supported void space. The trench, or bed, bottom infiltrative surface is fully exposed, sidewalls are generally louvered, and the top is generally solid.

- The chambers are placed, connected end-to-end, in the bottom of the trench (and placed side-by-side in a bed) and backfilled with native material (or as otherwise directed by the manufacturer depending upon soil conditions).

- At each end of each drainfield chamber line, solid end plates are installed for structural support and as a barrier to soil backfill.

- The use of a geotextile barrier between the chamber and the soil backfill varies from manufacturer-to-manufacturer, model-to-model (depending upon sidewall louver design), and depends on the type of soil in which the drainfield is installed.

Figure 2. Typical Gravelless Chamber Drainfield, Cross-Section



Gravel-substitute—(See Figure 3)

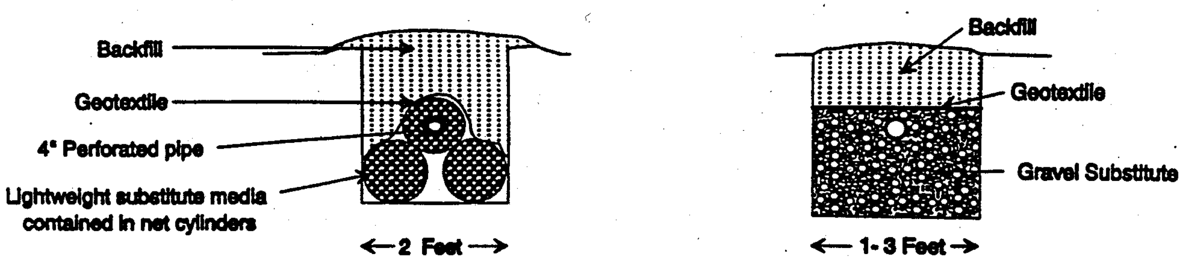
- Of the different types of gravelless drainfields, gravel-substitute drainfields are the most similar to gravel-filled drainfields.

- Substitute media may be loose, or contained in netting for ease of installation and/or as an element of design.

- The particular shape and configuration of the substitute media may provide additional void space within the trench or bed depending on how the units are placed and the depth and width of the drainfield trench.

- A geotextile material is placed on top of the substitute media as a barrier to soil backfill infiltration. Some product manufacturers, due in part to the shape of their product, prefer the use of other types of barrier materials, such as 60 pound untreated building paper. In loose soils such as uniform sands non-deteriorating geotextile barrier material may be needed, however, to assure long-term protection. In either case, the manufacture's recommendations for assuring against soil backfill infiltration should be followed.

Figure 3. Examples of Gravel Substitute Drainfields



Geocomposite gravelless drainfields are currently undergoing review by DOH and the TRC. Information about this product is included to facilitate ease and timeliness of inclusion in the recommended standards once approved by DOH.

Geocomposites—(See Figure 4)

- Drainfield void space is created by the assembly of multiple layers of geogrid and geotextile bundled together in size and shape to facilitate handling and placement.
- Structural integrity is imparted by the design and material elements of the geocomposites.
- Geocomposite drainfields may incorporate a layer of sand media between the geogrid/geotextile bundle and the bottom and sides of the drainfield trench or bed.
- An effluent distribution pipe is place on top of the geogrid/geotextile bundles.
- A geotextile material is placed on top of the geocomposite drainfield as a barrier to soil backfill infiltration.

Figure 4. Example of Geocomposite Drainfields

1. Performance Standards—

1.1. Listing—

1.1.1. DOH reviews and lists proprietary gravelless drainfield products when the manufacturer or designated manufacturer representative demonstrates that the product meets or exceeds the performance criteria.

1.1.2. Before a local health jurisdiction may issue a permit for an on-site wastewater system incorporating a gravelless drainfield, the specific brand and model must be included on the current DOH List of Approved Systems and Products (WAC 246-272-04001(2)).

1.2. Performance Criteria—Gravelless drainfields must provide, at least equal to that provided by gravel in a conventional gravel-filled drainfield, the following attributes:

1.2.1. Non-decaying, non-deteriorating. Gravelless drainfield material must not decay, deteriorate, or leach chemicals or byproducts when exposed to sewage and the subsurface soil environment.

1.2.2. Void Capacity / Storage Volume. Must be established by drainfield materials, design, and installation; must be maintained for the life of the drainfield. This may be met on a lineal-foot, or on an overall drainfield-design, basis.

1.2.3. Infiltrative Surface Exposure. Must provide effluent distribution to the soil interface. Drainfield sizing in Washington State is based on trench, or bed, bottom area only. Sidewall is not considered, in terms of drainfield sizing, except where total annual recharge is less than 12 inches per year.

1.2.4. Maintenance of the trench or bed integrity. Material used, by its nature and its manufacturer-prescribed installation procedure must withstand the physical forces of the soil sidewalls and soil back-fill.

Drainfield Size & Long-term Performance—*An element of drainfield performance (gravel-filled and gravelless) is "life-span." The length of time a drainfield functions satisfactorily depends on many factors including:*

- *Accuracy of initial drainfield design, matching the site and soil characteristics to the anticipated facility use and wastewater generation.*
- *Quality of materials and methods used in the installation of the drainfield.*
- *Care of use (operation) and timeliness of maintenance on the system.*

While not addressed above as an element of the Performance Criteria, the selection of an appropriate wastewater-to-soil application rate is critical to the treatment performance of the drainfield and the length of time that treatment performance is achieved. Gravelless drainfield manufacturers commonly encourage the use of their products in reduced configurations when compared to conventional gravel-filled drainfields. While this approach may be satisfactory due to unique elements of the product designs, these smaller drainfields may impact the life of the drainfield. Drainfield performance over the long-term (20 – 30 years) needs to be observed and analyzed as additional field experience with these systems is gained.

2. Application Standards—

2.1. Permitting—

2.1.1. Permitting and installation of gravelless drainfields are subject to local and state code.

2.1.2. Only proprietary gravelless drainfield products listed in the current edition of the DOH List of Approved Systems and Products may be permitted by local health jurisdictions (WAC 246-272-04001(2)). Only the specific models listed in the document are approved. If other models in a manufacturers' product-lines do not appear on the list, they are not approved for use in Washington State. If in doubt, contact DOH for current listing information.

2.1.3. Permit Requirements—The local health agency installation permit (and operational permit, depending on local code) must at least specify, among other items normally required within the specific local health jurisdiction, the following items:

(a) The design flow volume (gallons/day) for the facility served.

(b) The soil type (textural class number) at the site.

(c) The soil application rate (gallons/sq. ft./day) matched to the soil type and conditions.

(d) The drainfield size required (square feet) if a conventional gravel-filled drainfield were to be used.

(e) The size of the proposed gravelless drainfield (square feet) with % reduction, if used.

(f) The frequency of gravelless drainfield status observations.

(g) The requirements for drainfield expansion, repair, or replacement in event of observed problems. (See Section 4.3 for possible outcomes of observed ponding conditions.)

2.2. General Conditions—Gravelless drainfields may be used:

2.2.1. In applications and locations where soil and other site conditions are suitable for a conventional septic tank and drainfield system.

2.2.2. In conjunction with approved treatment systems, such as sand filters or aerobic treatment units, that may provide effluent quality sufficient for gravelless drainfields to be used on sites not otherwise suitable for a conventional septic tank and drainfield.

2.2.3. Where soil types and depths, setbacks, and other site evaluation and location requirements found in subsections -11001, -20501, and -09501 of WAC 246-272 are satisfactorily met.

2.2.4. Incorporating any combination of the following design elements:

(a) gravity-flow distribution;

(b) pressurized distribution;

(c) drainfield dosing; and,

(d) alternating drainfields.

2.2.5. In mounds and sand filters (and, when recommended standards and guidance is approved by DOH, in at-grade systems) in lieu of gravel-filled trenches or beds.

2.3. Soil Conditions—

2.3.1. Gravelless drainfields may be used in Soil Type 1A provided that the wastewater receives treatment at least equal to Treatment Standard 2 prior to discharge to the soil for final treatment and disposal. This may be accomplished by using the gravelless drainfield in a sand-lined drainfield trench with a minimum of 24" of sand media as detailed in the DOH <u>Recommended Standards and Guidance for Sand Filters</u>.

2.3.2. In Soil Types 4, 5, and 6, gravelless drainfields must be used in a trench configuration only: not to be used side-by-side in a bed. In Soil Types 1A, 1B, 2A, 2B and 3, gravelless drainfields may be used in a bed configuration with a maximum bed width of 10 feet. (Note: these restrictions also apply to gravel-filled drainfields.)

2.4. Minimum Land Area / Drainfield Area Requirements—

2.4.1. The use of a gravelless drainfield does not provide for a reduction in the minimum land area requirements established in WAC 246-272-20501. Site development incorporating gravelless drainfields must meet the minimum land area requirements established in state and local codes.

2.4.2. The drainfield area proposed for an on-site sewage system using gravelless drainfield products <u>must</u> provide for each drainfield (the initial and replacement) an area equal to 100% the size of a gravel-filled drainfield.

2.5. Influent Wastewater Characteristics—

2.5.1. Wastewater from residential sources must receive pre-treatment at least equal to that provided in a conventional two-compartment septic tank, before discharge to a gravelless drainfield.

2.5.2. Wastewater from non-residential sources, or high-strength wastewater from residential sources must receive pre-treatment sufficient to lower the waste-strength to the level of that commonly found in domestic residential septic tank effluent before discharge to a gravelless drainfield.

2.6. Installation—Gravelless drainfields must be installed according to the manufacturer's instructions, in a manner that is consistent with these standards, state and local rules. If the manufacturer's instructions and these standards are in conflict, the matter must be discussed with, and decided by, the local health officer.

3. **Design Standards / Proprietary Products**—Gravelless drainfield technologies are, for the most part, proprietary. As such, other than the Performance Criteria identified in Section 1.2, there are no specific design requirements for the manufactured products. There are, however, Design Standards relative to:

- the required vertical separation and the method of wastewater distribution;
- certain soil types and required use of pressure distribution;
- certain soil types and pre-treatment to levels meeting Treatment Standard 2;
- the minimum depth of gravelless drainfield trench;
- the size of the gravelless drainfield, based upon type-specific drainfield design values for effective infiltrative surface area.

3.1. Vertical Separation—Varies depending on method of effluent distribution.

3.1.1. With gravity-flow distribution, a minimum of three feet of vertical separation must be established by design and maintained by installation.

3.1.2. With pressure distribution, a minimum of two feet of vertical separation must be established by design and maintained by installation.

3.2. Pressure Distribution Required—Pressure distribution is required in Soil Types 1A and 2A (Table IV, WAC 246-272-11501).

3.3. Treatment Standard 2 Pre-treatment Required—Wastewater pre-treatment to levels meeting or exceeding the Treatment Standard 2 must be included in on-site sewage system designs using gravelless drainfields in Soil Type 1A, and in Soil Types 1B, 2A, 2B, 3 through 6 where the vertical separation is between 1 foot and 2 feet.

3.4. Drainfield Depth—Gravelless drainfields must be installed at a minimum depth of 6 inches into original, undisturbed soil.

> *DOH is working on the development of Recommended Standards and Guidance for At-Grade Drainfields. These recommended standards and guidance will likely establish conditions where gravelless drainfields may be installed at minimum depths less than 6 inches. Anticipated release date: December 1999.*

3.5. Drainfield sizing—Varies with the type and configuration of gravelless drainfield products. As a point of reference for a site-specific design, the amount of conventional gravel-filled drainfield must first be determined. This is done by dividing the daily design flow (in gallons) by the application rate, which varies according to Soil Type (See WAC 246-272-11501). Drainfield sizing in Washington State is based on trench, or bed, bottom area only, except where total annual recharge is less than 12 inches per year. Sidewall infiltration, while it is an acknowledged element of drainfield function, is not considered in terms of drainfield sizing. The List of Approved Systems and Products contains detailed information regarding the dimensions of gravelless drainfield products to assist in accurate drainfield sizing.

3.5.1. Conventional drainfield sizing criteria—

(a) Single-pipe gravelless drainfields—Calculate the required length of pipe using the effective areas for the appropriate diameter. The effective area per lineal foot of pipe is calculated based upon the outside diameter of the pipe.

> *Multiple-pipe gravelless drainfields are a new product in the gravelless drainfield market, currently undergoing review by DOH and the TRC. Information about this product is included to facilitate ease and timeliness of inclusion in the recommended standards once approved by DOH.*
>
> **Multiple-pipe gravelless drainfields**—Calculate the required multiple-pipe configuration and length needed according to the width of trench-bottom covered by the bottom of the bundle(s). The effective area per lineal foot of pipe is calculated based upon the outside dimensions of the pipe bundle(s) in contact with the bottom of the trench or bed.

(b) Gravelless chamber drainfields—Calculate the required length of chamber using the effective area for the particular chamber. The effective area per lineal foot of chamber is based upon the actual dimensional width of the chamber at the trench or bed bottom, not the nominal size or product marketing description.

(c) Gravel substitute drainfields—

Gravel substitute media must be in the same size range as gravel (3/4" to 2½").

The square feet of trench bottom area required is equal to that of a conventional gravel-filled drainfield. The amount of infiltrative surface per lineal foot of gravel substitute trench is equal to the trench-bottom area covered by the gravel substitute.

The gravel substitute must provide:

- a minimum 30% void volume under compression conditions encountered in a soil trench; and,
- total void volume per square foot of trench bottom equivalent to, or greater than, that in a gravel-filled trench.

See Appendix D, Table 1 for void volume of conventional gravel-filled drainfield trenches. In jurisdictions where more than 12 inches of gravel depth is required, additional calculation may be necessary to assure comparable void volume.

Geocomposite gravelless drainfields are currently undergoing review by DOH and the TRC. Information about this product is included to facilitate ease and timeliness of inclusion in the recommended standards once approved by DOH.

Geocomposite drainfields— Calculate the required number and size of geocomposite bundles needed according to the width of trench-bottom covered by the bottom of the bundle(s). The effective area per lineal foot of geocomposite drainfield is calculated based upon the outside dimensions of the bundle(s) in contact with the bottom of the trench or bed.

Product Manufacturer / System Designer Responsibilities—*When gravelless drainfield manufacturers promote, and on-site sewage system designers integrate in their client's sewage systems, reduced-size drainfields they share with the system owner the responsibility for satisfactory long-term function of the drainfield. It is not necessarily acceptable design practice to apply reduced-size gravelless drainfields in all soils, sites, or applications simply because the manufacturer's literature suggests, or the local and state minimum codes may allow, use of gravelless drainfield technologies in this manner.*

3.5.2. Reduced drainfield sizing criteria for Gravelless Chamber Drainfields—With 100% of the area required for a gravel-filled drainfield established and dedicated (for initial and replacement fields) reduced-size gravelless chamber drainfields may be designed and installed. System design, layout, and installation must be done in a manner easily facilitating the installation of additional gravelless drainfield if future conditions necessitate such action. For systems using pressure distribution, if additional drainfield is needed in the future, elements of the system (such as the pump or controls) may need to be modified in order to meet the hydraulic performance requirements of pressure distribution throughout the expanded drainfield system.

(a) Drainfield size reductions allowed varies according to soil types, as follows:

Soil Types 1A, 1B:	No Reduction Allowed
Soil Types 2A , 2B:	Up to 20% Reduction Allowed
Soil Types 3 through 6:	Up to 40% Reduction Allowed, except in soils with appreciable amounts of expandable clay (See Appendix C), where no reduction is allowed.

(b) Observation Ports—Must be installed in a representative location on <u>each</u> drainfield line. Some drainfield lines may require additional observation ports to achieve observations representative of the entire drainfield line. Specific information about observation ports is available in the text box following item 4.1.2.

Until more long-term experience applying reduced-size gravelless drainfields is gained, it remains imperative that long-term drainfield function and public health protection is assured by implementing the following:

- *Full drainfield areas for the initial and replacement area (providing full suitable area for expansion and replacement of the drainfield if needed.*
- *Strategically placed observation ports in each drainfield line to observe the infiltrative surface conditions and ponding levels within the drainfield.*
- *Regular observation of the drainfield to assure timely identification of pending problems in a timeframe that allows corrective action before public health is placed at risk due to a drainfield failure.*
- *System owner awareness of the potential for size-related drainfield issues, both in terms of needed diligence to Operation and Maintenance (O&M) and cost-of-repair issues.*
- *When choices are made regarding what type of drainfields to install, and how much drainfield to install, the choices must be well considered, intentional decisions made by both the designer and the on-site sewage system owner.*

3.6. Other Design Elements—Other design features, such as trench separation, maximum lateral lengths, vertical separation, maximum width and depth of trench, minimum depth of soil backfill, suitable backfill, required pretreatment, setbacks, etc., must be the same as for conventional drainfields. (See Chapter 246-272 WAC)

Combining Drainfield Size Reduction Allowances—

Gravelless Chamber with Sand Filter (Treatment Standard 2) Drainfield Size Reductions—*From a logic path perspective, combining the two drainfield size reductions—that based on the merits of gravelless drainfield technology and that based on the effluent quality of wastewater treated to levels meeting or exceeding Treatment Standard 2—makes sense. On this basis the Washington State On-Site Wastewater Technical Review Committee (TRC) has acknowledged, but not recommended, combining these reductions. There remain some questions about how prudent is the practice. Combining these reductions should only be done with careful consideration and only then when system safeguards are in place to assure that potential drainfield loading problems are identified in a timely manner and that there are reasonable options available for repair or modification of the drainfield. Gravelless chamber drainfield systems may not be used to reduce the size of mounds treating septic tank effluent or those treating effluent from Treatment Standard 1 or 2 treatment systems. (See Recommended Standards & Guidance for Mound Systems for design specifics.)*

Comparison of Reduced-Size Drainfields in Two U.S. States—

The allowances for reducing the size of gravelless drainfields are presented as a percentage reduction relative to the size of conventional gravel-filled drainfields. Conventional gravel-filled drainfields are sized by dividing the estimated Daily Design Flow (Washington State WAC minimum of 120 GPD / bedroom [2 persons / bedroom, 60 GPD / person]) by the Application Rate (for the particular soil found at the proposed system site).

One aspect of the technical justification for reducing gravelless chamber drainfields is the success obtained in other states when reductions are applied. When gravelless drainfields are reduced in size by applying a percentage reduction, the resulting size of drainfield is relative to the specific values for the Daily Design Flow and the Soil Application Rate. It is important to realize that different states commonly use different values for Daily Design Flow and Soil Application Rate. As these change, so does the resulting size of the reduced size gravelless drainfield. Compare the following examples:

Example 1:
3-bedroom residence, Soil Type 1A (Coarse Sand)

		Drainfield Size (sq.ft.)	
State "A"		Full Size	Reduced (20%)
Application Rate: (GPD/Sq.Ft.)	1.2	300	240
GPD/Bedroom:	120		
State "B"		Full Size	Reduced (40%)
Application Rate: (GPD/Sq.Ft.)	0.8	563	338
GPD/Bedroom:	150		

Example 2:
3-bedroom residence, Soil Type 3 (Fine Sand)

		Drainfield Size (sq.ft.)	
State "A"		Full Size	Reduced (40%)
Application Rate: (GPD/Sq.Ft.)	0.8	450	270
GPD/Bedroom:	120		
State "B"		Full Size	Reduced (40%)
Application Rate: (GPD/Sq.Ft.)	0.4	1125	675
GPD/Bedroom:	150		

Please note that in the first example State B ends up with a drainfield 1.4 times as large as the drainfield in State A. In the second example State B ends up with a drainfield 2.5 times as large as the drainfield in State A. These differences occur due to their different approaches to soil application rates, estimated daily design flows, and gravelless drainfield sizing reduction allowances. The resulting drainfields sizes will, however, impact the life span of these drainfields very differently due to the direct link of drainfield size to drainfield longevity.

The point here is that comparisons between states and recommendations for applying reduced-size gravelless drainfields may not always be as simple as it appears. Careful design consideration must be given to accurately match the proposed development, the existing soil characteristics, and the drainfield design elements to assure that the on-site sewage system will serve the client well, and protect public health, over the long term.

{State A: Washington; State B: Connecticut (source: R. May, 3/12/98)}

4. Operation and Maintenance Standards—

4.1. General—

4.1.1. The owner of the residence or facility served by the gravelless drainfield is responsible for assuring proper operation and providing timely maintenance for all components of the on-site wastewater treatment and disposal system.

4.1.2. The on-site wastewater system designer must instruct, or assure that instruction is provided to, the owner of the residence or facility regarding proper operation of the entire on-site wastewater system.

Observation Ports—*The installation of observation ports in on-site sewage system drainfields is encouraged for the purpose of monitoring system status and aiding in problem analysis. To be effective they must be installed in a representative location on <u>each</u> drainfield line. Some drainfield lines may require additional observation ports to observe conditions representative of the entire drainfield line.*

Well-designed and installed observation ports:

- *Extend to at least the ground surface of the final landscape grade.*
- *Are firmly anchored so as to prohibit unauthorized removal.*
- *Are accessible for routine observation.*
- *Are secured or otherwise protected from accidental or unauthorized access.*
- *Provide visual access to the trench-bottom in the gravel portion of a gravel-filled drainfield and, in gravelless drainfields:*

  ] Single-Pipe: to the interior of the pipe.

  ] Multiple-Pipe: to the infiltrative surface.

  ] Chamber: to the interior of the chamber.

  ] Gravel Substitute: to the infiltrative surface.

  ] Geocomposite: to the infiltrative surface.

4.2. O&M activities include—

4.2.1. Assuring that no surface water collects on the drainfield site.

4.2.2. Prohibiting any type of vehicular or livestock traffic over the drainfield area.

4.2.3. Maintaining a suitable, non-invasive shallow-rooted vegetative cover over the drainfield site.

4.2.4. Observing the entire on-site sewage system at a frequency appropriate for the site conditions and the on-site sewage system. This may be done by the homeowner or other persons, as appropriate.

4.2.5. Maintaining a written chronological record of drainfield ponding level observations, and operation and maintenance activities. If the system uses pressure distribution or other means of system dosing, the person monitoring the system needs to be aware of the impact of dose frequency on observed ponding levels.

4.2.6. Servicing all system components as needed, including product manufacturer's requirements / recommendations for service.

The frequency of observing on-site sewage system conditions, and the level of detail of information that is retained by the system owner and/or reported to the local health jurisdiction relates to risk presented by site conditions and system complexity. Monitoring and reporting to assure proper function becomes increasingly critical for more vulnerable sites and/or complex systems. Table 3 and Table 4 illustrate this concept and may be used to guide decisions related to observing and reporting.

Table 3. Relationship of Site Risk and System Complexity

Issue	**Characteristics / Level of Risk**		
	Lower Risk		**Higher Risk**
Site Risk	Meets state rules for *conventional gravity system*	Meets state rules for *conventional pressure distribution system*	**Risk increases with -** *less* vertical separation, smaller lot sizes, less horizontal separation, and, *greater surface* slope, wastewater flow, wastewater strength, etc.
System Complexity	Gravity-flow (no pumps, controls, etc.)	Pressurized distribution (requires pumps & controls)	**Complexity increases with -** *increasing* reliance upon, or combinations of: pumps; blowers; motors; mechanical, electronic, or computer-operated controls & warning devices; disinfection (materials & equipment); quality control of artificial (non-original soil) treatment media, etc.

Table 4. Suggested Monitoring Frequency Based On Risk and Complexity

	Level			
Site Risk	Low	Low	High	High
System Complexity	Low	High	Low	High
Monitoring Frequency	***Low = Annually***	***Medium = Semi-annually***		***High = Quarterly, or greater***

4.3. Observed Conditions / Actions—

4.3.1. When observation reveals either of the following listed conditions, the owner of the system must take appropriate action to alleviate the situation according to the direction and satisfaction of the local health officer.

- **(a)** Drainfield failure; or,
- **(b)** A history of long-term, continuous and increasing ponding of wastewater within the gravelless drainfield of such magnitude that if left unresolved, will probably result in drainfield failure.

4.3.2. Appropriate action may include:

- **(a)** Repair or modification of the drainfield.
- **(b)** Expansion of the drainfield.
- **(c)** Modifications or changes within the structure relative to wastewater strength or hydraulic flow.
- **(d)** For on-site sewage systems where a reduced-size gravelless drainfield was used, the repair or modification required may include the installation of additional gravelless drainfield units to enlarge the drainfield to 100% of the initial (gravel-filled) design size.

Local permits must be obtained before construction begins, according to local health department requirements.

Appendix A

Reduced-Size Gravelless Chamber Drainfields

In the early 1990's the Department of Health (DOH) in conjunction with the department's technical advisory group, the Technical Review Committee (TRC) evaluated the information available regarding gravelless chamber drainfields. At that time plastic (polyethylene) chamber units were new to the marketplace. The department and the TRC responded to two issues presented by representatives of the gravelless chamber industry. These two items were:

- *general application of plastic chamber products (previous experience was with concrete chambers); and,*
- *the manufacturer's recommendations for sizing gravelless chamber drainfields (resulting in a reduced-size drainfield when compared to conventional gravel-filled drainfields).*

In support of their request for product and drainfield sizing approval, industry representatives presented documentation from a variety of sources. Of the scientific papers submitted, some addressed experience with chamber drainfields, some introduced the concept of "stone-masking", but none of them provided direct side-by-side comparison of gravelless chamber drainfields (reduced-size) and conventional gravel-filled drainfields. Nonetheless, considering all the information and data provided, plus presentations by industry representatives, the TRC recommended that DOH establish a set of interim standards for the use of reduced-size gravelless chamber drainfields. DOH implemented this recommendation by approving the Interim Special Requirements for Reduced-Size Gravelless Chamber Drainfield Systems.

In spring 1998 DOH was again approached by representatives of the gravelless chamber drainfield industry regarding the standards presented in the <u>Guidelines for Gravelless Drainfield Systems</u>. At that time DOH and the TRC considered the industry's request to modify the standards. Specifically DOH was requested to:

- *Allow the use of pressure distribution with reduced-size gravelless chamber drainfields on sites where the vertical separation is greater than 2 feet but less than 3 feet. (This would align the provisions of the guidelines with the requirements in the Chapter 246-272 WAC for pressure distribution on sites with vertical separation between 2 feet and 3 feet).*
- *Extend to Soil Types 2A & 2B the same reduction allowed for Soil Types 3 through 6 (40% instead of 20%).*
- *Remove the identifier "Interim Special Requirements" for the reduced-size provisions.*

Similar to the events of the early 1990's, presentations were made and gravelless chamber drainfield product experts provided supporting documents. The documentation provided this time, unlike the first time, did present information from research studies of gravelless chamber drainfields. Among the eight or so studies submitted, some were characterized by side-by-side studies comparing gravelless chamber drainfields with gravel-filled drainfields.

Though the presentations and documentation was provided to support the industry's request for modification to the special requirements for reducing gravelless chamber drainfields, the department and the TRC took the opportunity to re-evaluate the general concept of reducing gravelless chamber drainfields. Unfortunately, for a variety of reasons, the scientific and experience-based studies available neither prove, nor disprove, the concept that the appropriate size of gravelless chamber drainfields is 40% less than gravel-filled drainfields. This is not to say that the information available from research studies and experience with gravelless drainfields is inconsequential. Considerable effort and energy has been expended in the pursuit of solid scientific documentation of the relative performance levels of gravelless chamber drainfields and gravel-filled drainfields. While interpretations of these studies differ depending upon individual perspective, the researchers remain reluctant to state with a high degree of certainty that the apparent outcome of their studies represent solid scientific proof of gravelless chamber drainfield performance.

The issues surrounding the application of reduced-size gravelless chamber drainfields are complex and the discussions among members of the TRC and DOH Wastewater Management Program have been thoughtful. The presentations before the TRC and the scientific and experiential supporting documentation have been extensively reviewed. An element to emerge from these discussions and review of the literature is that in terms of public health, the reducing of gravelless drainfield sizing is much more of a drainfield longevity issue than it is a wastewater treatment issue. Initially reduced-size drainfields may perform better than full-sized drainfields, in that the flow-modulating biomat will likely develop quicker in drainfields that are loaded at a higher loading rate. Once the biomat is developed, wastewater flow rate through the biomat to the surrounding soil promotes wastewater treatment in aerobic, unsaturated flow conditions. Some degree of unknown remains, however, regarding the lifespan of reduced-size gravelless drainfields.

In the development of technical standards, policies, and guidance application of the scientific method is preferred. Applying the best available scientific information to the decision processes help assure that the public health is protected. Obtaining such information and basing technical standards on well-documented, independent, scientific research has long been the goal of the DOH. There do occur, however, situations where absolute scientific confirmation remains beyond our reach. This appears to be the case in the matter of reduced-size gravelless chamber drainfields. It may be that the full understanding of the appropriate application rate for gravelless drainfields may be achieved in a manner similar to how public health and on-site sewage treatment and disposal science arrived at the appropriate application rates for gravel-filled drainfields. How was this done? By experience, 10, 20, and 30 years of experience, observation and analysis, in addition to the available research information.

This observation does not suggest that we have gone blindly off into the unknown, simply hoping that reducing drainfield size is appropriate. Until we gain more long-term experience applying these gravelless drainfield technologies this way, it remains imperative that long-term drainfield function and public health protection is assured by implementing the following:

- *Full drainfield areas for the initial and replacement area (providing full suitable area for expansion and replacement of the drainfield if needed.*

- *Strategically placed observation ports in each drainfield line to observe the infiltrative surface conditions and ponding levels within the drainfield.*

- *Regular observation of the drainfield to assure timely identification of pending problems in a timeframe that allows corrective action before public health is placed at risk due to a drainfield failure.*

- *System owner awareness of the potential for size-related drainfield issues, both in terms of needed diligence to O&M and cost-of-repair issues.*

- *When choices are made regarding what type of drainfields to install, and how much drainfield to install, the choices must be well considered, intentional decisions made by both the designer and the on-site sewage system owner.*

TRC & DOH Response to Industry Requests—

In considering the manufacturer's requests, the TRC and the department:

- *Agreed that allowing the use of reduced-size gravelless chamber drainfields with pressure distribution on sites with vertical separation between 2 feet and 3 feet would be consistent with the state on-site rules.*

- *Did not agree to extend the 40% reduction allowance provided for Soil Types 3 through 6 to Soil Types 2A & 2B, leaving instead the reduction allowance for these soil types at 20%. The TRC continued to hold to concerns for wastewater treatment performance in coarser soils when the resulting application rate was higher than for conventional gravel-filled drainfields.*

- *Agreed to the manufacturer's request that the reference to "Interim Special Requirements" be dropped. This was appropriate when considering that the entire set of recommended standards and guidance documents are reviewed and revised at least once in every three years (all the information is subject to change within these 3-year long interim periods). Likewise, as all of the guidance documents provide the special requirements for the different alternative technologies, labeling certain parts of a specific document as "special" seems redundant.*

Other Changes in the Revised Recommended Standards and Guidance—

- *With emphasis being placed on O&M activities, the requirements previously identified in the Performance Monitoring section have been modified. This has been done in coordination with local health jurisdictions as they develop their programs for assuring that on-site sewage system owners are aware of their O&M responsibilities and have access to qualified service technicians.*

- *The section detailing the course of action to be taken in the event of (1) drainfield failure or (2) a condition of long-term, continuous and increasing ponding of wastewater in the drainfield, has been moved to the general recommended standards. This applies to all gravelless drainfields including both full-size and reduced-size gravelless chamber drainfields.*

- *Consistent with the increased level of information to be recorded with on-site sewage system permits (WAC 246-272-09001) the provisions of the Permit Requirements section have also been moved to the general recommended standards. These apply to all gravelless drainfields including both full-size and reduced-size gravelless drainfields.*

- *The requirement for two observation ports in each drainfield line has been modified to require at least one, but more if necessary to accurately determine ponding level conditions throughout each drainfield line.*

- *The prohibition of the use of serial distribution has been dropped. Current members of the TRC and the DOH Wastewater Management Program could not identify technical justification for this flow distribution restriction.*

J. Mark Soltman, R.S., Supervisor
Wastewater Management Program
November 1998

Appendix B

Identifying Soil With Expanding Clay

Please Note: *The following information has been provided by Lisa Palazzi to address the issue of appreciable amounts of expandable clay. Ms. Palazzi is a private-sector soil scientist and a member of the department's Technical Review Committee.*

A Vertisol is one of the 11 Taxonomic Soil Orders, and is defined as having slickensides (smeared planes within the soil profile) at least 10 inches thick within the top 40 inches of soil, and having 30% clay content and having cracks that open and close periodically. The slickensides and cracks imply that the clay content is primarily expanding clays, as those features occur concurrently only with expanding clays. Vertisols are identified in general textbooks as being generally incapable of supporting septic drainfields, although many septic systems are installed and functioning in Texas Vertisols. This success however, is thought to be a result of their very low rainfall climate.

Expanding clays - such as montmorillonite or smectite or bentonite - can be defined on a mineralogic level as being composed of a 2:1 alumino-silicate crystalline lattice, as compared to non-expanding clays - such as kaolinite (the red Georgia clays) - which have a 1:1 crystal lattice form. From a more practical perspective, they can be defined by a measurement of how much they shrink when taken from a saturated water content to a dry water content. That measurement is called a Coefficient of Linear Extensibility (COLE) and a 9% change is considered definitive of having a significant montmorillonite content. At another scale, the distance between two montmorillonite crystal lattices when dry is reported as being 9.6 angstroms; and when exposed to 50% relative humidity, expanding to 10's or even hundreds of angstroms. So it is obvious that even a very small amount of expanding clay can have a huge effect on soil drainage characteristics. 5-10% content could be considered "appreciable".

It is important to note that there are few areas with expanding clays north of the terminus of the continental glacier (about Tenino for western Washington). Areas south of that however could have some Vertisols, although they are not terribly common. If we need a measure of expansion potential, the COLE process could be applied with fairly simple tools. One simply mixes a soil/water solution to the point where the clay soil is almost saturated, but can still be formed into a "worm" or rod-shaped lump. The length of the rod is measured. Then the rod is placed in an oven to dry (250 degrees for about an hour should be enough), then re-measured. If the length of the rod decreases by more than 3-5%, there is probably enough expanding clay to affect soil drainage potential. I chose 3-5% somewhat arbitrarily mainly because it is about one third to one half that of that used to indicate significant content of montmorillonite (9%).

Appendix C

Definitions

Alternative System: *an on-site sewage system other than a conventional gravity system or conventional pressure distribution system. Properly and maintained alternative systems provide equivalent or enhanced treatment performance as compared to conventional gravity systems.*

Approved List: *"List of Approved Systems and Products", developed annually and maintained by the department and containing the following:*

(a) List of proprietary devices approved by the department;
(b) List of specific systems meeting Treatment Standard 1 and Treatment Standard 2;
(c) List of experimental systems approved by the department;
(d) List of septic tanks, pump chambers, and holding tanks approved by the department.

Conventional Gravity System: *an on-site sewage system consisting of a septic tank and a subsurface soil absorption system with gravity flow distribution of the effluent.*

Disposal Component: *a subsurface absorption system (SSAS) or other soil absorption system receiving septic tank or other pretreatment device and transmitting it into original, undisturbed soil.*

Drainfield (conventional): *an area in which perforated piping is laid in drain rock-packed trenches, or excavations (seepage beds) for the purpose of distributing the effluent from a wastewater treatment unit.*

Effluent: *wastewater discharged from a septic tank or other on-site sewage system component.*

Experimental System: *any alternative system without design guidelines developed by the department or a proprietary device or method which has not yet been evaluated and approved by the department.*

Failure: *a condition of an on-site sewage system that threatens the public health by inadequately treating sewage or creating a potential for direct or indirect contact between sewage and the public. Examples of failure include:*

(a) Sewage on the surface of the ground;
(b) Sewage backing up into a structure caused by slow absorption of septic tank effluent;
(c) Sewage leaking from a septic tank, pump chamber, holding tank, or collection system;
(d) Cesspool or seepage pits where evidence of ground water or surface water quality degradation exists; or
(e) Inadequately treated effluent contaminating ground water or surface water.
(f) Noncompliance with standards stipulated on the permit.

Final Treatment/Disposal Unit: *that portion of an on-site sewage system designed to provide final treatment and disposal of the effluent from a wastewater treatment unit, including, but not limited to, absorption fields (drainfields), sand mounds and sand-lined trenches.*

Infiltrative Surface: *in drainfields, the drain rock-original soil interface at the bottom of the trench; in mound systems, the gravel-mound sand and the sand-original soil interfaces; in sand-lined trenches/beds (sand filter), the gravel-sand interface and the sand-original soil interface at the bottom of the trench or bed.*

Influent: *wastewater, partially or completely treated, or in its natural state (raw wastewater), flowing into a reservoir, tank, treatment unit, or disposal unit.*

On-site Sewage System: *an integrated arrangement of components for a residence, building, industrial establishment or other places not connected to a public sewer system which:*

(a) Convey, store, treat, and/or provide subsurface soil treatment and disposal on the property where it originates, upon adjacent or nearby property; and
(b) Includes piping, treatment devices, other accessories, and soil underlying the disposal component of the initial and reserve areas.

Proprietary Device or Method: *a device, or method classified as an alternative system, or a component thereof, held under a patent, trademark or copyright.*

Residential Sewage: *sewage having the consistency and strength typical of wastewater from domestic households.*

Septic Tank: *a watertight pretreatment receptacle receiving the discharge of sewage from a building sewer or sewers, designed and constructed to permit separation of settleable and floating solids from the liquid, detention and anaerobic digestion of the organic matter, prior to discharge of the liquid.*

Sewage: *any urine, feces, and the water carrying human wastes including kitchen, bath, and laundry wastes from residences, building, industrial establishments or other places. For the purposes of these guidelines, "sewage" is generally synonymous with domestic wastewater. Also see "residential sewage."*

Treatment Component: *a class of on-site sewage system components that modify and/or treat sewage or effluent prior to the effluent being transmitted to another treatment component or a disposal component. Treatment occurs by a variety of physical, chemical, and/or biological means. Constituents of sewage or effluent may be removed or reduced in concentrations.*

Treatment Standard 1: *A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 200 fecal coliform/100ml.*

Treatment Standard 2: *A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 800 fecal coliform/100ml.*

Vertical Separation: *the depth of unsaturated, original, undisturbed soil of Soil types 1B - 6 between the bottom of a disposal component and the highest seasonal water table, a restrictive layer, or Soil Type 1A.*

Wastewater: *water-carried human excreta and/or domestic waste from residences, buildings, industrial establishments or other facilities. (See SEWAGE.)*

Wastewater Design Flow: *the volume of wastewater predicted to be generated by occupants of a structure. For residential dwellings, this volume is calculated by multiplying the number of bedrooms by the estimated number of gallons per day (GPD), using either the minimum state design standard (120 GPD) or the locally established minimum standard (such as 150 GPD).*

Appendix D

Conventional Gravel-Filled Drainfields / Void Space and Infiltrative Surface Area—

Conventional gravel-filled drainfields typically consist of a level trench (3 ft. wide) or bed (>3 ft. <10 ft. wide) with 6 to 12 inches of gravel placed on the bottom. A gravity flow distribution network consisting of 4-inch diameter perforated plastic pipe is located on this layer of gravel. Additional gravel is placed over the pipe to a level 2 inches above the pipe. The gravel is then covered with a layer of geotextile material and the trench is backfilled with native soil material.

Conventional gravel-filled drainfields are sized according to trench (or bed) bottom area only. The treatment and disposal contribution of the trench sidewall is acknowledged, but is not considered for drainfield sizing. This conservative approach to drainfield sizing provides a prudent margin of error when designing soil-treatment and disposal-based on-site sewage systems. For base-line design purposes the void space and infiltrative surface area of a conventional gravity flow gravel-filled drainfield trench with a 1-foot depth of gravel and a 4-inch diameter distribution pipe is presented in Table 1 and Table 2.

Table 1. Void Volume in a One-Foot Length of Conventional Gravel-filled Drainfield Trench

Drainfield Trench (gravel portion)	Volume (Gross) V_g (in ft^3)	Volume (4.5” O.D. Pipe) $V_{4.5"}$ (in ft^3)	Volume (Net) $V_N = V_g - V_{4.5"}$ (in ft^3)	% Void Volume $VV_{\%}$ (in ft^3)	Total Void Volume $VV_T = V_N \times V_{\%} + V_{4.5"}$ (in ft^3)
12” (H) x 30” (W) x 12”(L)	1’ x 2.5’ x 1’ = 2.5	(Ξr^2 x 12”) / 1728 = .11	2.39	(washed drainrock) at least.30	2.39 x .30 + .11 = .83
12” (H) x 36” (W) x 12”(L)	1’ x 3’ x 1’ = 3	(Ξr^2 x 12”) / 1728 = .11	2.89	(washed drainrock) at least.30	2.89 x .30 + .11 = .98

Table 2. Infiltrative Surface in a One-Foot Length of Conventional Gravel-filled Drainfield Trench

Drainfield Trench (gravel portion)	Infiltrative Surface Per Lineal Foot of Trench	
	Bottom Area Only (WAC 246-272-11501(2)(I)	Bottom Area + 6” sidewall* (WAC 246-272-11501(4)(e).
12” (H) x 30” (W) x 12”(L)	Two & one-half (2.5) square feet	Three & one-half (3.5) square feet
12” (H) x 36” (W) x 12”(L)	Three (3) square feet	Four (4) square feet

WAC 246-272-11501(4)(e): The local health officer or department may allow the hydraulic loading rate calculated for the infiltration surface area in a disposal component to include six (6) inches of the SSAS sidewall height for determining design flow where total recharge by annual precipitation and irrigation is less than twelve (12) inches per year.